(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 March 2004 (25.03.2004)

PCT

(10) International Publication Number
WO 2004/024546 A1

(51) International Patent Classification[7]: B62K 15/00

(21) International Application Number:
PCT/CA2003/001406

(22) International Filing Date:
12 September 2003 (12.09.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2,402,992 12 September 2002 (12.09.2002) CA

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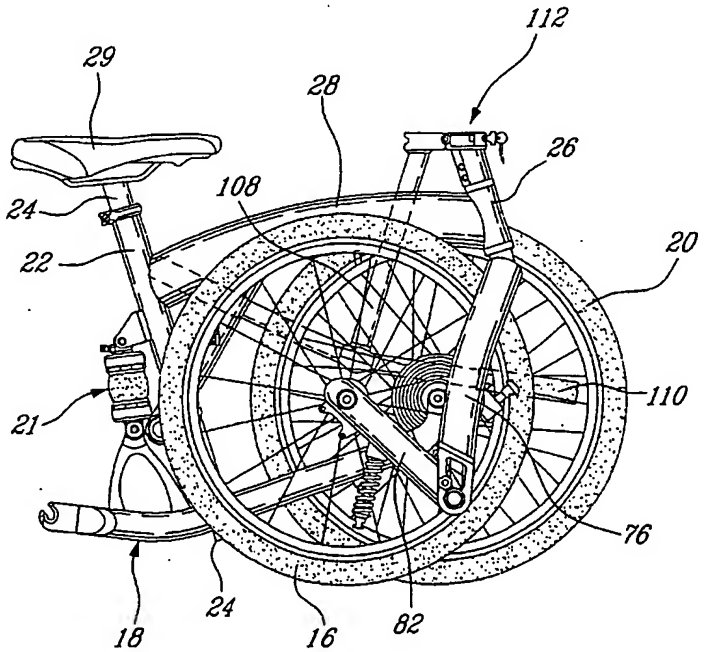
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,

[Continued on next page]

(54) Title: FOLDING BICYCLE



(57) Abstract: A folding bicycle (10) comprises a main frame (12), a front frame (14) carrying a front wheel (16) and a rear frame (18) carrying a rear wheel (20). The front and rear frames (14 and 18) are pivotable and laterally deflectable off the plane of the main frame (12) to permit positioning of the front and rear wheels (16 and 20) on opposed sides of the main frame (12). The folding pivot points of the front and rear frames (14 and 18) are perpendicular to the plane of the main frame (12) and are respectively integrated to a front suspension (19) and a rear suspension (21).

WO 2004/024546 A1

SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

FOLDING BICYCLE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to bicycles and, more particularly, to folding bicycles.

Description of the Prior Art

Folding bicycles have been around for decades. The most common type of folding bicycle in the market today is described as the "door hinge" style. This style is characterized by sectioning the bicycle's main frame with one or more folding hinge mechanisms that allow the user to fold the bicycle along a vertical axis. Usually, the hinge is positioned in the middle of the bike allowing the wheels to be brought next to each other when folded. Seen from above, the bike would have the appearance of "U" shape with the wheels being at the tip of each line. A single hinge is typically used to save on costs and simplify the design. This results in a limited ability to bring down the folded size of the bike to only half of its overall length. It is for this same reason that most of the folding bike manufacturers will reduce the wheelbase of the bicycles, limit themselves to using very small diameter wheels (8" to 16") thus reducing the efficiency of the bicycle, and make compromises in the geometry of the bicycle to help them reduce the overall folded size of the bike.

There is thus a need for a new folding bicycle which would offers a riding position, a riding behavior, and fell that is similar to the one experienced on a standard full-size upright bicycle.

SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to provide a folding bicycle adapted to deliver superior riding performance.

It is also an aim of the present invention to provide a folding bicycle having optimized riding geometry.

It is a further aim of the present invention to provide a folding bicycle which offers riding performance similar to that of a traditional bicycle.

It is a still further aim of the present invention to provide a folding bicycle which performs well on the road but still compact when folded.

Therefore, in accordance with the present invention, there is provided a folding bicycle comprising a front frame member, a rear frame member and a main frame member. The front and rear frame members are allowed to fold towards the main frame member resulting in a final folded position that lies within the squared surface of the main frame member, thereby providing a very compact folded state. Consequently, no compromise had to be done to the design criteria outlined above with respect to the prior art folding bicycles.

According to a further general aspect of the present invention, the folding motions of the front and rear frame members are each set to pivot on an axis perpendicular to the plane of the bicycle. The suspension pivots can advantageously be used as the folding pivot points of the front and rear frame members, thus allowing the bicycle design to remain simple to make and use, as well as light weight.

According to a still further general aspect of the present invention, the bike design make use of intrinsic and original features to laterally deflect the front and rear frame members to allow them to be positioned on each side of the main frame member when in a folded position. When viewed from above, the front and rear frame members appear to be parallel to each other but they are also skewed at an angle of approximately 10^0 in relationship to the main frame member. This folding pattern is herein referred to as "the reversed Z" style pattern.

According to a further still general aspect of the present invention, the angular deflection of the front frame member is accomplished by using the intrinsic pivoting features of the front fork steering mechanism lodged in the head tube of the main frame member. The angular deflection of the rear frame member results from a torsional movement that is allowed by the rear suspension member which is lodged in an axis normal to the ground and situated just behind the bottom bracket of the chain wheel.

Despite the angular deflection of the front and rear frame members allowed by the present design when folding the bicycle, the present design still offers perfectly perpendicular axis of all the suspension pivots and rotational points of the bicycle in relationship with the riding plane of the bicycle when the bike is in its useable configuration. More particularly, in the riding position, the pivot point of the folding forward arm of the fork as well as the rear fork member on which the rear wheel is attached are perfectly perpendicular in the x and y directions if the riding axis of the bike is considered to be Z.

Furthermore, the suspension pivot points are perfectly parallel to the front and rear wheel axles. This permits the forward and rear wheels to travel upwards, in the plane of the bike when the suspensions are actuated. If the forward and/or rear suspension pivot points were not perfectly perpendicular to the riding plane of the bike, the front and rear wheel would be skewed at an angle when either suspension would be actuated causing the bike to loose its line, affecting the steerability and balance of the bicycle and potentially cause the loss of control of the bicycle. This design criteria is common practice in the art of designing conventional, non-folding dual-suspension bicycle which is dictated by common sense and safety considerations.

The proposed bike geometry has been advantageously designed to adapt to all size of riders from small person to men measuring up to 6' 3" making it a one size fits all bicycle.

Even though the proposed bike geometry is built around the use of 20 in. wheels which are very common in the market, the design can be effectively adapted to different size wheels from 16 inches to 26 inches whilst respecting all claims.

Furthermore, according to a feature of the present invention, the bicycle can stand on its own when folded because the secured folded positions of the front and rear wheels, as well as the forward fork ends of the rear fork, form a rectangular plane of four contact points to the ground, effectively holding the unit upright.

According to a general aspect of the present invention, the folding bicycle comprises a bicycle main frame with original geometry, featuring an original dry bearing pivot with an original quick-release skewer to fasten and release the rear fork and allow pivoting of the rear fork. The invention may feature as well, an original chain tensioning device fixed to the underside of the bottom bracket shell for picking-up the chain slack caused by the chain line variations when the suspension is actuated whilst riding, as well as the variations when the rear fork assembly is folded (this device is used only in the case of single speed or internal geared rear hub specifications)

According to a still further general aspect of the present invention, the folding bicycle may comprise an original front fork of monoblade trailing link design with an original, releasable spring suspension device. The bicycle may also feature a low spoke count front wheel and original compact hub fitted with a hub mounted brake.

According to a still further general aspect of the present invention, the folding bicycle may comprise an original rear fork linking the rear wheel to the main frame with an original forward fork end ramping design to automatically latch the quick release skewer in place when unfolding the bicycle to its riding configuration. The bicycle may also feature original suspension geometry and fastening system to the frame via original cold forged suspension braces.

According to a still further general aspect of the present invention, the folding bicycle may comprise an original automatic safety latching system that secures the rear fork member onto the main frame pivot bearing unit preventing the rear fork member to accidentally release itself from the main frame assembly prior to the quick-release skewer being secured in place.

According to a still further general aspect of the present invention, the folding bicycle may comprise an original collapsible steering column with an original quick-release skewer type fastening folding hinge allowing the handlebar stem arrangement to fold alongside the main frame when in folded position.

According to a still further general aspect of the present invention, the folding bicycle may comprise an original saddle with an integrated carry pouch.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred embodiment thereof, and in which:

Fig. 1 is a side elevation view of a folding bicycle in accordance with a preferred embodiment of the present invention;

Fig. 2 is an enlarged perspective view of a rear suspension unit and of the forward ends of the rear fork of the bicycle illustrating how the rear fork is releasably pivotally connected to a pivot bearing unit of the main frame of the bicycle;

Fig. 3 is a cross-section of the pivot bearing unit shown in Fig. 2;

Fig. 4 is an enlarged top perspective view of the rear fork;

Fig. 5 is a perspective view of the forward ends of the rear fork;

Fig. 6 is a front elevation view of the front fork of the bicycle;

Fig. 7 is a perspective elevation view of a foldable steering column of the folding bicycle shown in Fig. 1;

Figs. 8 to 11 are schematic side views of a quick-release skewer type fastening folding hinge illustrating the folding sequence of the steering column;

Fig. 12 is a schematic top plan view of the bicycle; and

Figs. 13 to 16 are schematic side views of the bicycle illustrating the folding sequence thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now referring to the drawings, and in particular to Fig. 1, a transportable folding bicycle embodying the elements of the present invention and generally designated by the numeral 10 will be described.

The folding bicycle 10 generally comprises a main frame 12, a front frame 14 carrying a front wheel 16 and a rear frame 18 carrying a rear wheel 20. As will be seen hereinafter, the front and rear frames 14 and 18 are pivotally connected to the main frame 12 for allowing the bicycle 10 to be folded in a compact collapsed position when not in use. Integral to the folding pivot designs

of the front frame 14 and the rear frame 18 are front and rear suspension units 19 and 21 that effectively dampen the ride when cycling adding to the comfort of the user. According to a preferred embodiment of the present invention, the rear suspension unit 21 comprises a rubberized inflatable air chamber 23 (see Fig. 2) at opposed end of which is screwed top and bottom aluminum caps 25 and 27. For instance, the rear suspension unit 21 could consist of an Airshox GT-130 suspension unit.

The main frame 12 includes a seat tube 22 for receiving a seat post 24 supporting a saddle 29, a head tube 26, a curved horizontal top tube 28 linking the seat tube 22 and the head tube 26, and a diagonal tube 30 that triangulates between a bottom bracket shell 32 (Fig. 2) to the top tube 28. Tubing material may be steel, or steel alloys, or aluminum alloys (eventually, a metal alloy cast, or a molded thermo-set frame could be devised along the same geometric guidelines). More specifically, the top tube 28 is curved with a R800 radius to allow both front and rear wheels 16 and 20 to tuck in closer in a more compact fashion. If the top tube 28 was straight it would interfere more so with the wheels 16 and 20.

The seat tube 22 is round in shape and positioned at a 73° angle leaning towards the back of the bicycle. This is to allow the sat position of short and tall riders to be biomechanically correct considering the variance in height of the saddle 29 to pedal relationship. Furthermore, at its base, the seat tube 22 runs through a mitered opening in the diagonal tube 30 just in front of the bottom bracket shell 32 (Fig. 2). The seat tube 22 is open at both ends allowing the seat post 24 to run freely inside and extend past the bottom opening when folding the bicycle. A quick-release clamp 34 is provided at the upper end of the seat tube 22 for releasably securing the seat post 24 in position. Finally, a U-shaped bracket 36 is brazed to its back to pivotally support the top cap 25 of the rear suspension unit 21.

The diagonal tube 30 is of a variable section, going from a round shape at its connection with the top tube 28, to an oval shape when connecting to the bottom bracket shell 32. The ovalization of the tube 30 shows the wider

diameter of the tube 30 to be perpendicular to the plane of the bicycle thus strengthening the bottom bracket shell connection allowing it to better resist to the lateral flexing induced by the pedaling motion. The diagonal tube 30 is mitered at a cross-section perpendicular to the plane of the bicycle, at a position close to the circumference of the chain wheel 31 to accept a cylindrical shell 38 (Fig. 3) that houses a pivot bearing unit 40 with a releasable fastening mechanism 41 adapted to secure the rear frame 18 to the pivot bearing unit 40 when in riding configuration.

The pivot bearing unit 40 is similar in function to a hollow axle front wheel hub. It serves to connect the rear frame 18 to the main frame 12 and allows the rear frame 18 to pivot upwards as the suspension is actuated in riding conditions. The pivot bearing unit 40 dictates the proper tracking of the bicycle 10 through the precise alignment of the front wheel 16 with the rear wheel 20. Therefore, the bore tolerance of the cylindrical shell 38 must be of H7. The pivot bearing unit 40 includes a pair of dry bearing units 42 that are fitted into opposed open ends of the shell 38. The two dry bearing units 42 can be of the Iglidur WFM variety by IGUS. As shown in Fig. 3, the pivot bearing unit 40 further includes a two part hollow shaft 44 extending axially through the shell 38 within the dry bearings 42. The hollow shaft 44 includes first and second members 44a and 44b screwed into each other in the middle of the shell 38. The shaft members 44a and 44b are machined to a shaft tolerance of H9. They can be made of 303MX stainless steel or 6001 T6 hard anodized aluminum. As will be seen hereinafter, the shaft 44 is provided at opposed ends thereof with a pair of shoulders 50 for receiving the rear fork forward ends of the rear frame 18. The two part shaft 44 defines an axially extending central through hole 46 for receiving a quick-release skewer 43 operational for releasably securing the forks of the rear frame 18 to the shaft 44.

The frame pivot quick-release skewer 43 is slid inside the hollow shaft 44 with the skewer lever 45 being positioned on the right hand side of the bicycle 10. A compression spring 47 must be positioned between the right shoulder 50 of the shaft 44 and the skewer lever 45. No spring is to be set between the left shoulder 50 and the skewer nut 49.

As shown in Figs. 1 and 4, the rear frame 18 is provided in the form of a rear fork having left and right side chain stays 54a and 54b linking the rear wheel 20 to the main frame 12. The stays 54a and 54b are braced by two perpendicular bridges 56 located within the first 1/3 of the length of the stays 54a and 54b, starting from the main frame 12. This dual bridge configuration is to further strengthen the rear fork assembly and allow it to further resist to torsional forces imposed by the pedaling motion.

Projecting below the left and rear stays 54a and 54b are wishbone-shaped members 58a and 58b (Fig. 2) which act as rear suspension braces. These two members 58a and 58b may be CNC machined or forged and are pierced to receive a bolt 60 running across the bottom end to link to the bottom cup 27 of the rear suspension 21. The shape of each brace member 58a and 58b features a large central opening 62 (Fig. 2) in order not to interfere with the radial expansion of the rubber member defining the inflatable air chamber 23 of the rear suspension 21 when compressed. At both ends of the rear fork stays 54a and 54b are the forward fork ends 64a and 64b (Figs. 2 and 4) that connect the rear fork to the main frame 12 (described below) and rear fork ends 66a and 66b (Fig. 1) that are shaped to receive the rear wheel hub and mount the rear disk brake.

As shown in Fig. 5, the forward fork ends 64a and 64b are specifically designed to cooperate with the main frame pivot quick-release skewer to provide a safety latching mechanism. This safety latching mechanism acts as an added security device to prevent the accidental release of the rear fork when it is fastened to the main frame pivot bearing unit 40, especially if the user has forgotten, or did not properly fasten the quick-release skewer 43 of the pivot bearing unit 40 prior to riding the bicycle 10. This safety latching mechanism was devised as an added precautionary measure to ensure the safe use of the bicycle 10. The mechanism results from the original shape given to the forward fork ends 64a and 64b of the rear fork, each fork end 64a and 64b having a different shape from the other; the long travel quick-release skewer of the main frame pivot; and an original use of the skewer compression spring 47 which is strategically positioned to make the system work.

First, the forward fork ends 64a and 64b of the rear fork are slotted vertically with an opening towards the ground which actively hooks onto the extensions of the pivot shaft 44. This orientation of the slots 65a and 65b intrinsically serves as a security preventing the rear fork from disengaging from the main frame pivot when considering that the rider's weight, when sat on the bicycle 10, effectively pushes down on the fork ends 64a and 64b as the rear fork pivots around the rear suspension pivot points. For added safety, the left fork end 64a is shaped to allow the quick release skewer nut 49 to ramp up and then fall into a circular shaped recess 68a slightly larger in diameter to the nut with a ridge of 2.5 mm. The right forward fork end 64b does not feature this recessed shape. The quick-release skewer lever 45 must be positioned on the right side of the bicycle (opposite the left side ramp and recess for the nut) and must feature a extension spring between the skewer and the right side pivot shaft 44b to effectively push the lever outwards and consequentially push the left nut 49 inside the recess 68a of the left forward fork end 64a. The resulting safety latching system would therefore help prevent the rear fork from disengaging even if the rear wheel 20 is lifted from the ground as in the case of the rider hitting a bump while riding and, of course, in the event that the quick-release skewer has not been secured to compress the forward fork ends 64a and 64b in place on the main frame pivot shaft 44.

When the user wishes to release the rear fork or rear frame 18 from the shaft 44, for instance when he wishes to fold the bicycle 10, he must simply push on the lever side of the skewer to compress the spring 47 after having opened the lever 45 to release the pressure of the skewer.

It is noted that the cam of the skewer must allow for a minimum travel of 5 mm or more in order to clear the automatic safety latching mechanism.

As shown in Fig. 1, the bicycle 10 further includes a chain tensioning device 70 comprising an aluminum arm 72 of a given length determined by the size of the chain wheel 31 used (a variable length arm is considered to adapt to these variances). One end of the arm 72 is fixed to the underside of the bottom bracket shell.32. This end must be allowed to pivot by a minimum of 50° on the same axis of the plane of the bicycle 10. The opposite end of the arm 72 is fitted

with a pulley wheel 74 which is in contact with the underside of the lower line of the chain line 33, very close to the chain wheel 31. A strong spring would be required to keep the chain tensioning device 70 in contact with the chain 33 at all times when riding the bike 10 or when folding the bike. The chain tensioning device 70 is required when the bicycle 10 is fitted with single speed or internal geared hub (any specification where no rear derailleur is used). It is meant to deal with the chain line variances that occur: a) when the bike is ridden and the rear suspension unit 21 is actuated (from a 435.5 mm chain line in the relaxed position to 460.3 mm when the rear suspension is compressed to its limit), and b) when the rear triangle (i.e. the rear frame 18) is folded (from 435.5 mm in the relaxed position to a minimum of 362 mm in the folding sequence). Furthermore, the chain tensioning device 70 would be allowed to pivot around its axis under the bottom bracket shell by about 50° to pickup the chain 33 slack when the rear fork is folded.

As show in Figs. 1 and 6, the front frame 14 is provided in the form of a front fork featuring a trailing link suspension design as well as a monoblade construction. The front fork has a right sided single blade 76 extending from a fork crown 78 (Fig. 6) down towards the back of the front wheel 16 to a U-shaped pivot bracket 80 situated at a point close to the outer circumference of the front wheel 16 as well as slightly below the hub axle height in relationship to the ground. The pivot point 80 joins a near horizontal arm 82 that is terminated by a fork end 84 on which the front wheel hub is attached. The intrinsic characteristics of a trailing link suspension as described above are: a) the suspension remains active in all riding situations, b) its anti-dive feature meaning; when the brake is activated, the clockwise motion of the wheel (when considering the bike from the drive train side) will in fact bear a load on the pivot suspension that will tend to open the angle of the pivot, thus resisting forward plunging of the bicycle. This results in safer, more controlled handling in critical situations.

The monoblade construction is justified in order to create a slimmer profile fork assembly contributing to a more compact folded assembly. Furthermore, the monoblade 76 is positioned on the right of the bicycle in order: a) not to interfere with the rear fork assembly when the bike is folded, b) to

protect the wheel 16 and bicycle 10 as it is positioned on the outside surface of the bicycle 10 when the unit is folded (it must be pointed out that the finish on the monoblade fork as well as the rear fork is a sandblasted anodized finish which is highly scratch resistant and harder wearing than paint). Finally, the monoblade configuration is justified for simplification of the design and ease of manufacturing contributing to a lighter end unit and a lower production cost (compared to a dual blade trailing link design).

The U-shaped pivot bracket 80 at the lower end of the main blade 76 holds the fore arm 82 of the fork through the use of a stainless steel shaft pivot bracket (not shown) using dry bearings (not shown). Furthermore, this bracket features a small spring'd ball stopper 88 on the inside left surface of the bracket. This little stopper 88 is strategically positioned to stop the fore arm 82 from falling out of its folded position when the front fork is folded-up.

The front suspension unit 19 is provided in the form of a releasable spring suspension unit extending between the monoblade 76 and the fore arm 82. The front suspension unit 19 completes the triangulation between the monoblade 76 and the fore arm 82. The front suspension unit 19 comprises a stainless steel spring 90 with a spring rate of 5.8 kg/mm and a lever ratio of 1.70 mm/mm. The maximum compression travel of the spring 90 is of 40.3 mm giving the front fork a maximum travel at the hub axle of 2.55 in. The spring 90 is fixed at one end to the fore arm 82 via an expandable round socket 92. The top end of the spring 90 is fitted with a slotted hook shaped plate 94. The plate 94 is designed to slide inside a bracket 96 which is brazed onto the monoblade 76 of the front fork. The bracket 96 is provided with a spring loaded knob 98 which automatically secures the hook shaped plate 94 when it slides into the bracket 96 when the front fork is set back into its riding position. To release the lower arm 82 to pivot to its folded position the user has simply to pull on the spring loaded knob 98.

As show in Fig. 1, the front wheel 16 features a low spoke count (16 or 18 spokes 100) with a 2-cross pattern. This will allow the rear derailleur to lodge between the spokes 100 when the front wheel 16 positions itself alongside of the

rear wheel 20 when the bike is folded. This contributes to a tighter folded position by preventing the rear derailleur to hit the spokes 100 when using more spokes on the wheel.

The front wheel 16 has an original front hub 102 with a total width of 80 mm compared to 100 mm for regular hubs used on common bicycles using dual bladed forks. This again allows for a more compact and narrow wheel resulting in a closer folded position. Also, the use of this original compact hub 102 has several advantages: it shortens the leverage of the outer load on the axle resulting in a stronger and stiffer fork to wheel assembly (Note: the theoretical loss of lateral strength of the wheel due to the shallower triangulation caused by the shorter distance between the flanges is irrelevant when comparing to full size bikes considering the use of smaller 20 in. diameter wheels). Furthermore, the narrow hub 102 is configured with a hub body which features a distance of 50.6 mm between the flanges provided at opposed ends of the body. This will allow the wheel 16 to be built with a mirrored dish on each side of the wheel (spoke angle is the same on both sides) resulting in a stronger easier to build wheel (spoke angle on left = spoke angle on right).

A disk type braking system is required for this design with the disk rotor (not shown) mounted on the right side along the arm 82 and the brake (not shown) being similarly mounted on the arm 82.

Finally, the axle of the hub features a counter clockwise thread on the end that screws into the fore arm 82 of the fork. This is to prevent accidental unscrewing of the fork if a foreign object would hinder the natural rotation of the wheel 16 while the bike is ridden. Similarly, the disk brake rotor bracket features a counter clockwise thread in order to prevent the disk rotor to be unscrewed when the user brakes.

As shown in Figs. 1 and 7, the transportable folding bicycle 10 further comprises a foldable handlebar and stem assembly 106 comprising a stem 108 on which a handlebar 110 is bolted on its top portion or brazed to form a T-shaped unit. The stem 108 could also be sectioned with an extension unit (not shown) that will allow the overall length of the stem 108 to be adjusted by the user

(optional). In the case of the bicycle being fitted with a conventional outboard headset with lock ring, the stem 108 would be fastened to the fork pivot through the use of a quill with an expandable nut and bolt. In the case of a Ahead TM style headset, whether outboard or inboard, the quill would extend to the bottom end of the fork crown 78 and the star locking nut and cap of the headset would also be mounted at the bottom of the fork crown 78. In either case, the stem 108 would be fitted with an original folding and latching mechanism 111 at its base, close to the top of the headset assembly.

The geometric characteristics of this design are specifically intended to optimize the final folded position of the handlebar and set it snugly over the folded rear wheel 20 on the left side (opposite side of the drive train) of the main frame 12.

The folding and latching mechanism 111 utilizes a quick-release skewer 112 similar to the one used on the main frame pivot bearing unit 40. As shown in Figs. 8 to 11, the quick release skewer 112 includes a top hinge plate 114 from which the post 108 extends upwardly in a forwardly inclined direction, a bottom hinge plate 116 from which a head steerer tube bracket 117 depends, a pivot 118 for pivotally connecting the top hinge plate 114 to the bottom hinge plate 116, an extension spring 120 fixed at a first end thereof to the pivot 118 and at a second opposed end thereof to a ¾" diameter locking cylinder 122 extending crosswise relative to the plates 114 and 116, a 5 mm quick release rod 124 with a loop formation 126 fixed to the pivot 118 and a king Kong long travel quick release cam 128 operable by a lever 130. The spring 120 is fitted about the rod 124 to act on the locking cylinder 122. The top and bottom plates 114 and 116 each define a semi-circular recess 132 at the front thereof for receiving the locking cylinder 122 transversally therein in order to releasably lock the plates 114 and 116 together.

To allow the top plate 114 to pivot away from the bottom plate 116, one has simply to displace the lever 130 from the position shown in Fig. 11 to the position illustrated in Fig. 10, thereby causing the cam 128 to move away from the locking cylinder 122. In this way, the cylinder 122 can be subsequently moved out

of the recesses 132, thereby allowing the top plate 114 to pivot away from the bottom plate as illustrated in Figs. 8 and 9.

As can be appreciated from Figs. 1, 2 and 12, the folding motions of the front and rear wheels 16 and 20 are set to pivot on respective pivot axes perpendicular to the plane of the bicycle making use of the front and rear suspension pivots 136 and 138 (Fig.12). The rear suspension 21 through its rubber member 23 allows the lateral displacement of the rear fork out of the plane of the main frame 12 to position the rear wheel 20 alongside of the plane of the bike. The front fork is deflected to its near parallel position to the main frame 12 when folded by pivoting the front steering assembly. Despite the angular deflection of the front and rear frames 14 and 18 allowed by the present design when folding the bicycle, the present design still offers perfectly perpendicular axis of all the suspension pivots and rotational points of the bicycle in relationship with the riding plane of the bicycle when the bike is in its useable configuration. More particularly, in the riding position, the pivot point of the folding forward arm 82 of the front fork as well as the rear fork 18 are perfectly perpendicular in the x and y directions if the riding axis of the bike is considered to be Z. Furthermore, the suspension pivot points are perfectly parallel to the front and rear wheel axles. This permits the forward and rear wheels to travel upwards, in the plane of the bike when the suspensions are actuated.

In order to fold the bicycle 10, the user must not be sat on the bike. He must be standing alongside the bicycle 10 with the bicycle 10 resting with its front and rear wheels 16 and 20 on the ground in order to effect the following different steps. Although not compulsory, we recommend the user be alongside the right side of the bike (side of the drive train). The following procedure is explained from that perspective.

Step 1 - Folding the rear triangle (Fig. 13)

In order to prevent potential pedal conflict with the front wheel in the folding sequence, it is advisable to position the right crank arm at the 12 o'clock position as a first step. The user then releases the quick-release skewer 43 by flipping lever 45 to the "open" position, thus releasing the pressure of the

skewer on the rear fork forward fork ends 64a and 64b. The user must then push on the lever side of the skewer in order to compress the skewer spring thus releasing the left side nut 49 of skewer 43 from the recess 68a embossed in the left forward fork end 64a of the rear fork. Whilst maintaining pressure, the user must lift the rear of the bike (lifting saddle up) to allow forward fork ends 64a and 64b to clear the pivot unit 40.

In the case of a rear derailleur spec'd bicycle: The rear wheel 20 is then free to pivot around the bottom pivot point 60 of the rear suspension 21. During the pivoting motion of the rear wheel 20, the elastic cord as well as the spring tension in the rear derailleur cage will hinder the backward swing of the rear shock thus limiting the chain line variations to a minimum, preventing the chain from disengaging from the chain wheel 31.

In the case of a single speed or internal geared hub spec'd bicycle: The rear wheel 20 is then free to pivot around the bottom pivot point 60 of the rear suspension 21. During the pivoting motion of the rear wheel 20, the elastic cord will hinder the backward swing of the rear shock thus limiting the chain line 33 variations to a minimum. The chain tensioning device 70 will pick up all of the chain slack caused by the chain line variations during the complete rotation of the rear fork 18 and prevent the chain 33 from disengaging from the chain wheel 31.

Before the rear wheel 20 passes the 6 o'clock position during pivoting motion, the user must point the front wheel 16 slightly towards the left of the bike (as if he was steering the bike towards the left while riding). This will prevent the front wheel 16 from conflicting with the final folded position of the rear wheel 20.

After the rear wheel 20 passes the 6 O'clock position in its folding motion the user must deflect the rear wheel 20 so the rear wheel 20 will find its final folded place alongside the left of the horizontal to beam 28 of the main frame 12. This lateral deflection of the wheel 20 is permitted by the torsional features that are inherent to the rear suspension unit that is used on the bike (it must also be said that the bike design would also work even without a rear

suspension unit as long as a the rear fork 18 and main frame 12 would be connected by a linkage unit in place of the suspension: this same linkage unit would allow the same torsional movement). Furthermore, the intrinsic properties of the rubber compound allows this torsion to occur as well as resisting to this motion (memory) thus preventing the rear wheel 20 to be deflected overtly resulting in a close tucked position of the rear wheel 20 against the main frame 12 when fully rotated in its final folded position (note: the lateral deflection of the rear fork towards the left side of the bike does not contribute to the disassembly of the rear suspension unit 21 since the central rubber chamber 23 of the suspension unit 21 is screwed clockwise into the suspension caps 25 and 27 and secured by a lock ring (not shown). The rear deflection movement contributes to further tightening of the unit).

The final folded position of the rear fork 18 is determined by two limiting factors: 1) the rear suspension braces 58a and 58b will come in contact with the bottom bracket shell 32 and prevent the rear fork 18 from pivoting further, and 2) the rear fork 18 will be held into a fixed position preventing the rear triangle to pivot back by Step. 2 described as follows:

Step 2 - Collapsing the saddle/seat post assembly (Fig. 14)

The seat post 24 is secured into the seat tube 22 by the collar 34 seated at the top of the seat tube 22 onto which a quick-release skewer exerts the required pressure to keep the seat tube 22 from sliding down when user rides the bike. When opening the cam lever of the quick-release skewer, the seat post 24 is permitted to slide inside the seat tube 22. The user must then push the saddle/seat post assembly down as far as it will go (up to when the seat post head touches the seat collar 34). When fully collapsed, the bottom end on the seat post 24 will then extend past the bottom opening of the seat tube 22. Furthermore, the seat post 24 will slide between the two chain stays 54a and 54b of the folded rear fork 18 and just behind the chain stay bridge next to the rear wheel 20. Thus, if the user picks up the folded bike, the rear fork 18 will not fall down and stay in its folded position. It must be noted that the position of this chain stay bridge has been optimized in order to lock the rear fork 18 in its optimal folded position. Also to

be noted, the length of the seat post 24 (530 mm between the fork head and the bottom tip) has been optimized to allow the tip of the seat post 24 to hook the seat stay bridge without touching the ground when the bike is completely folded in its upright position resting on the ground.

Step 3 - Folding the front fork (Fig. 15).

The user must first ensure that the front wheel 16 is pivoted to point towards the left by approx. 10° (as if the user was turning left while riding the bike). This places the front wheel 16 in parallel with the folded rear wheel 20. Afterwards, the user must release the locking hook 94 of the suspension spring assembly 19 by pulling on the mushroom shaped knob 98 on top of the bracket above the spring 90. This frees the horizontal fore arm 82 holding the front wheel 16 to pivot backwards around the pivot point situated in the elbow bracket 80 of the fork 14. The front wheel 16 is then free to rotate by about 270° to arrive at its optimal folded position. This position is determined by 3 parameters: 1) the limit of the rotation is dictated by the horizontal arm 82 abutting the inside of the elbow bracket, 2) the horizontal arm 82 will, at one point, compress the spring loaded ball bearing stopper device 88. When the arm 82 is rotated beyond the device 88, the stopper will prevent the front wheel 16 from unfolding when the user picks-up the bike. To unfold, the user must push down the wheel 16 beyond the spring loaded stopper 88 to unfold the fork. 3) Finally, the front wheel 16 finds its optimal folded position when the user puts the folded bike on level ground. At this stage in the folding sequence, the bike will stand by itself, balanced on the front wheel 16, back wheel 20, and top surface of the chain stays 54a and 54b and forward fork ends 64a and 64b as they rest flat on the ground.

Step 4 - Folding the stem/handlebar assembly (Fig. 16)

The final step in folding the bike is to open the quick release skewer lever 130 on the folding hinge plates 114 and 116 at the base of the folding stem 108. The long travel cam 128 of the quick-release skewer 112 releases the round cylinder 122 mounted crosswise on the opposite side to the hinge. The cylinder 122 is then free to ramp-up from its position and allow the stem/handlebar assembly to pivot around the hinge of the plates 114 and 116. The handlebar/stem assembly will

then pivot to the point where the handlebar 110 will rest against the front tire. There is no device planned to secure the handlebar 110 in its folded position since gravity prevents it from unfolding itself to its erect riding position. The user can then safely pick up and carry the folded bike.

Unfolding the bicycle

In essence, if the above steps are performed backwards and in a backwards order, the user will then unfold the bicycle 10 back to its riding state. Both folding and unfolding sequences can be performed in about 10 seconds each.

In view of the foregoing, it can be seen that contrary to most of the available folding bikes, the folding bicycle 10 has been designed considering the riding characteristics and behavior of the bicycle, as well as the rider's efficiency and comfort as prime concerns that should not be compromised over the simple convenience of making it a compact portable folding bicycle. The design offers a riding position, riding behavior, and feel that is similar to the one experienced on a full-size upright (safety style) bicycle. This is achieved by respecting the same basic geometric and biomechanical measurements that define bicycle performance and the cyclist's efficiency, like: wheelbase measurement (when comparing the distance between the contact points to the ground of the front and rear wheel, the present invention provided with 20 in. wheels has the same wheelbase as a ICF sanctioned 700c racing bicycle), saddle to handlebar distance and height relationship, steering angle and fork rake.

CLAIMS:

1. A folding bicycle comprising a main frame, a front frame carrying a front wheel and a rear frame carrying a rear wheel, said front and rear frames being pivotable and laterally deflectable off a plane of said main frame to permit positioning of the front and rear wheels alongside of the main frame when folded, and a latching system for releasably securing said front and rear frames in a riding configuration with said main frame, wherein said rear frame is set to pivot on a pivot axis perpendicular to said main frame.

2. A folding bicycle as defined in claim 1, wherein a linkage is pivotally connected at a first end portion thereof to said rear frame and at a second end portion thereof to said main frame, said linkage having a lateral flexibility for allowing said rear frame member to be deflected laterally along one side of the main frame after having been pivoted downwardly in the plane of the main frame.

3. A folding bicycle as defined in claim 2, wherein said linkage includes a resilient member.

4. A folding bicycle as defined in claim 2, wherein said rear frame is provided with a pair of forward fork ends adapted to be releasably hooked onto a pivot bearing unit extending laterally on both sides of the main frame.

5. A folding bicycle as defined in claim 4, wherein a quick-release skewer is mounted in said pivot bearing unit to selectively prevent said forward fork ends from moving out of engagement with said pivot bearing unit.

6. A folding bicycle as defined in claim 4, wherein said forward fork ends are slotted vertically with an opening towards the ground.

7. A folding bicycle as defined in claim 5, wherein said quick-release skewer comprises a nut adapted to fall in a recess defined in a first one of said forward fork ends, said quick-release skewer having a biasing member urging said nut into said recess to prevent unintentional disengagement of said forward fork ends from said pivot bearing unit.

8. A folding bicycle as defined in claim 4, wherein said main frame includes a horizontal top tube, a seat tube and a diagonal tube which triangulates between the top tube and the seat tube, and wherein said pivot bearing unit extends perpendicularly laterally through said diagonal tube.

9. A folding bicycle as defined in claim 8, wherein said diagonal tube is of variable section, going from a generally round shape to a generally oval shape.

10. A folding bicycle as defined in claim 8, wherein said seat tube is inclined towards a rear end of the bicycle.

11. A folding bicycle as defined in claim 8, wherein said top tube links the seat tube to a head tube, and wherein said top tube is curved to allow both front and rear wheels to tuck in closer in a more compact fashion.

12. A folding bicycle as defined in claim 8, wherein the seat tube has a top open end and a bottom open end for allowing a seat post to run freely inside and extend past the bottom open end when folding the bicycle.

13. A folding bicycle as defined in claim 1, wherein the pivot axis of said rear frame is integrated to a rear suspension including a resilient member having a lateral flexibility for allowing said rear frame member to be deflected laterally along one side of the main frame after having been pivoted downwardly in the plane of the main frame.

14. A folding bicycle as defined in claim 1, further including front and rear suspensions, and wherein said front and rear frames have respective folding pivot points relative to said main frame, said folding pivot points being integrated to said front and rear suspensions.

15. A folding bicycle as defined in claim 1, wherein said front frame comprises a monoblade fork including a single blade member and a wheel carrying arm pivotally connected to a lower end portion of the single blade member for pivotal movement about a point of pivot, and wherein a front suspension unit is provided between the single blade member and the wheel carrying arm, one of said single blade member and said wheel carrying arm being disconnectable from said suspension unit.

16. A folding bicycle as defined in claim 16, wherein said front suspension unit is fixed at a first end thereof to said wheel carrying arm, said front suspension unit having a second end opposite said first end thereof releasably engageable with a bracket provided on said single blade member.

17. A folding bicycle as defined in claim 16, wherein said point of pivot is close to the outer circumference of the front wheel as well as generally below the axle of the front wheel.

18. A folding bicycle as defined in claim 1, further comprising a foldable handlebar and stem assembly including a stem fitted with a folding and latching mechanism.

19. A folding bicycle as defined in claim 19, wherein the folding and latching mechanism includes a top hinge plate from which the post extends, a bottom hinge plate from which a head steerer tube bracket depends, a pivot for pivotally connecting the top hinge plate to the bottom hinge plate, and a latch for

releasably locking the top hinge plate against pivotal movement relative to the bottom hinge plate.

20. A folding bicycle as defined in claim 20, wherein said latch includes a quick-release skewer.

21. A folding bicycle comprising a main frame, front and rear forks respectively carrying front and rear wheels, said front and rear forks being mechanically releasable for respectively allowing said front and rear wheels to pivot into a folded position alongside of the main frame, wherein said rear fork has a folding pivot axis perpendicular to a plane of said main frame and is linked to said main frame so as to be laterally movable off the plane of said main frame.

22. A folding bicycle as defined in claim 22, wherein said rear fork is resiliently deflected against one side of the main frame.

23. A folding bicycle as defined in claim 23, further including a rear suspension, and wherein said folding pivot axis is integrated to said rear suspension.

24. A folding bicycle as defined in claim 24, wherein said rear suspension comprises a resilient member having sufficient flexibility for allowing said rear fork to be deflected laterally out of the plane of the main frame.

25. A folding bicycle comprising a main frame, a front frame carrying a front wheel and a rear frame carrying a rear wheel, said front and rear frames being pivotable and laterally deflectable off a plane of said main frame to permit positioning of the front and rear wheels alongside of the main frame when folded, and a latching system for releasably securing said front and rear frames in a riding configuration with said main frame, wherein a linkage is pivotally connected at a first end portion thereof to said rear frame and at a second end portion thereof to said main frame, said linkage being laterally movable relative to said main frame

for allowing said rear frame member to be deflected laterally along one side of the main frame.

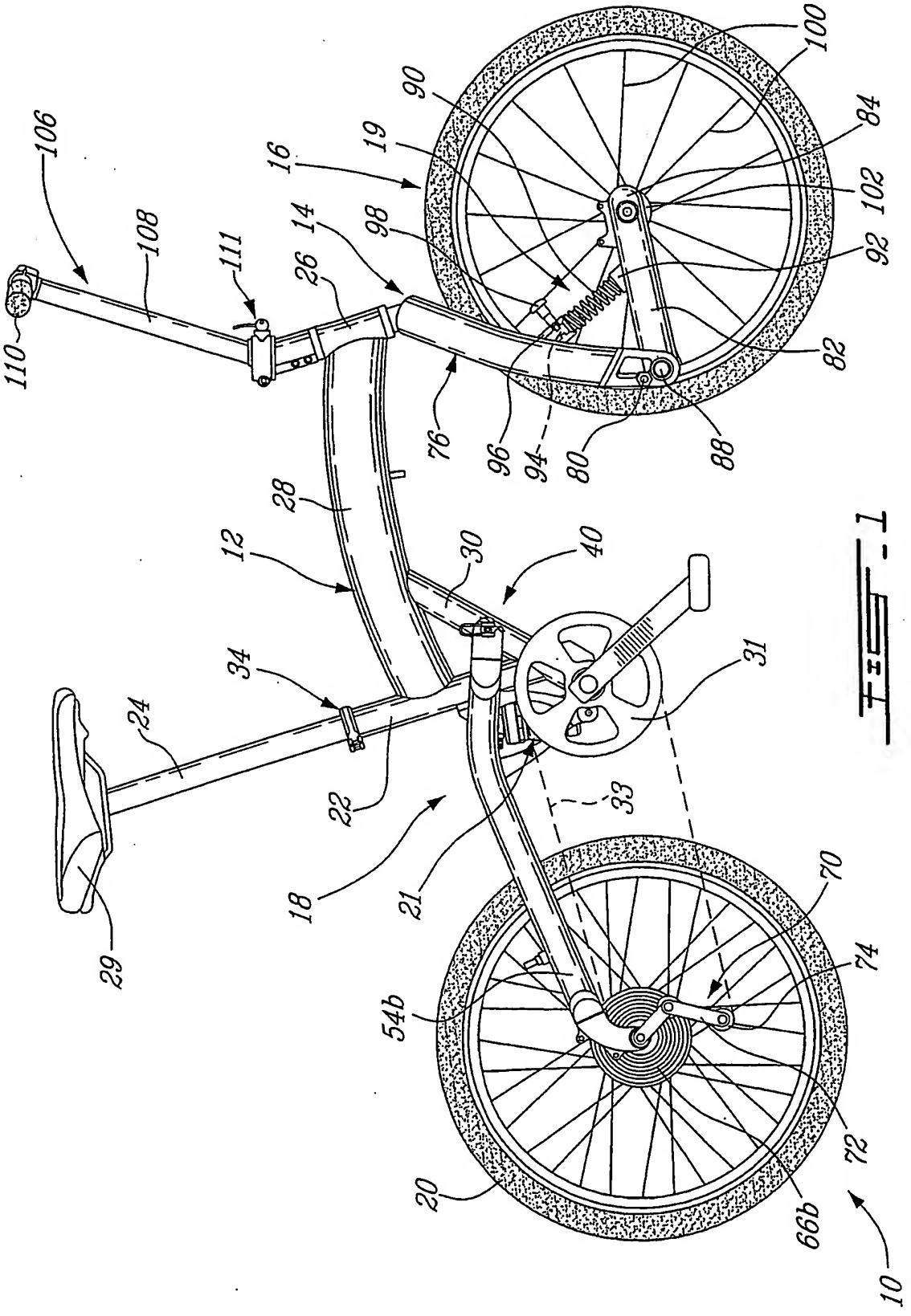

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Fig - 1

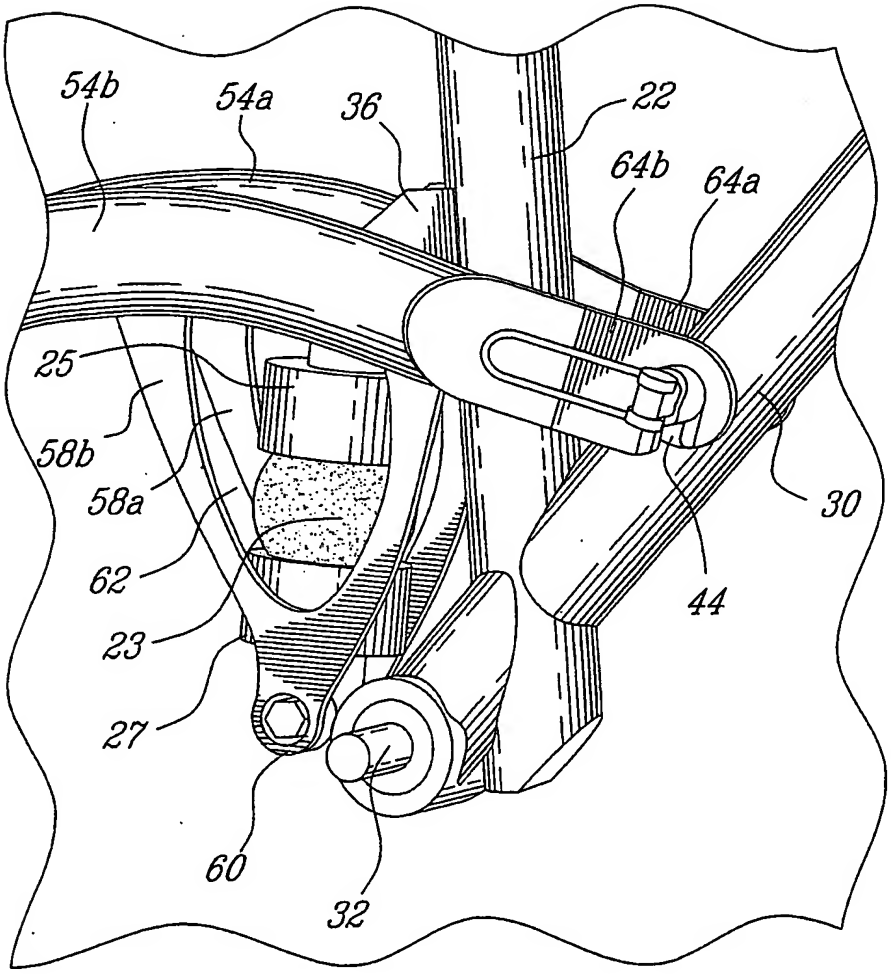
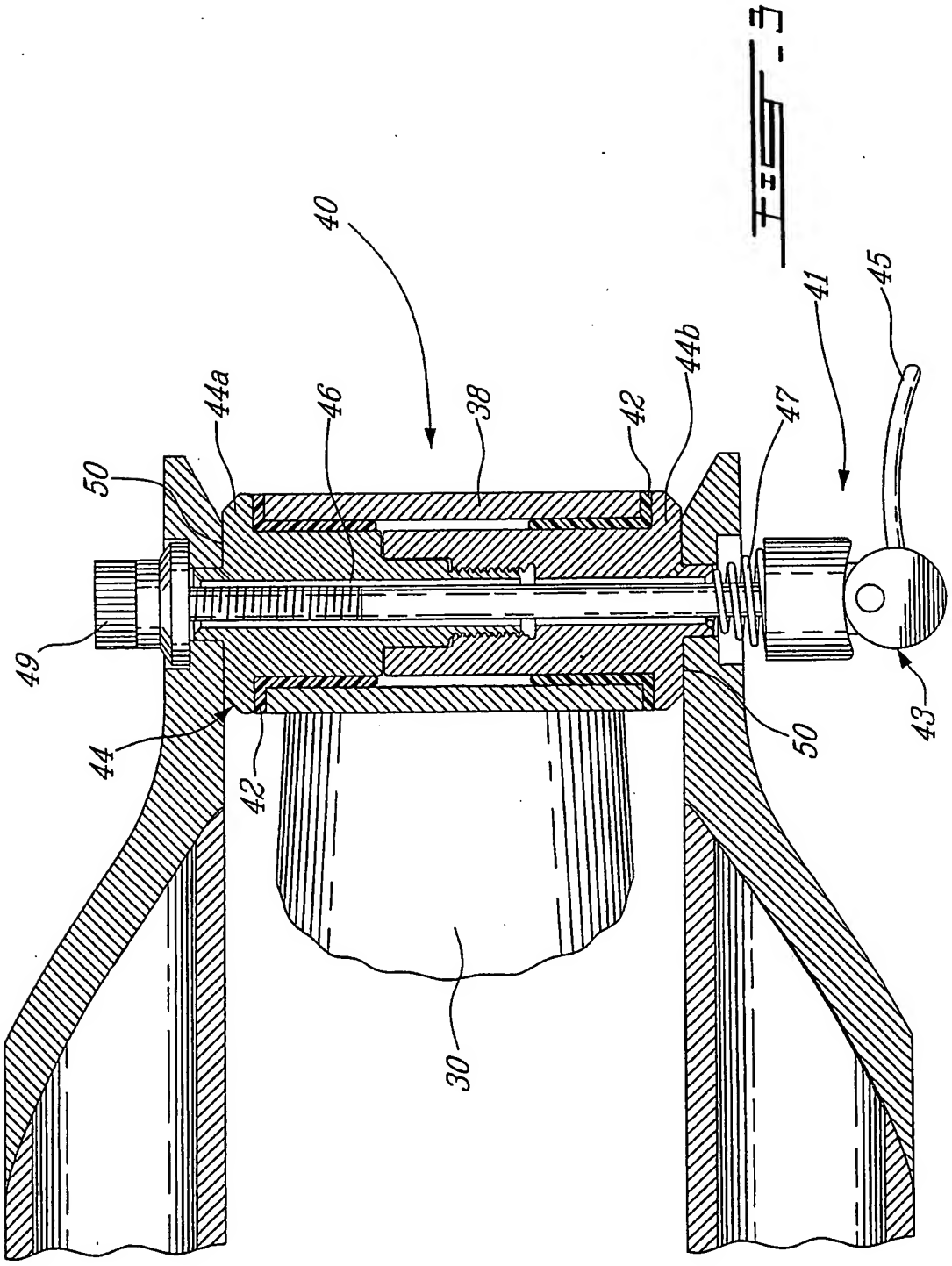


Fig. 2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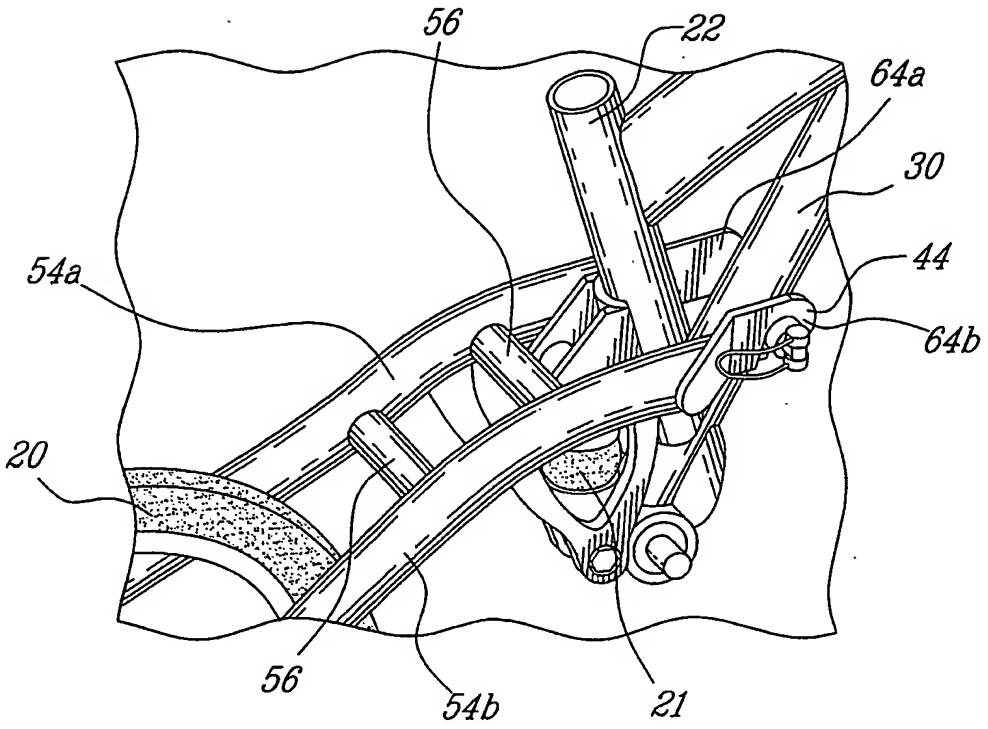

Fig. 4

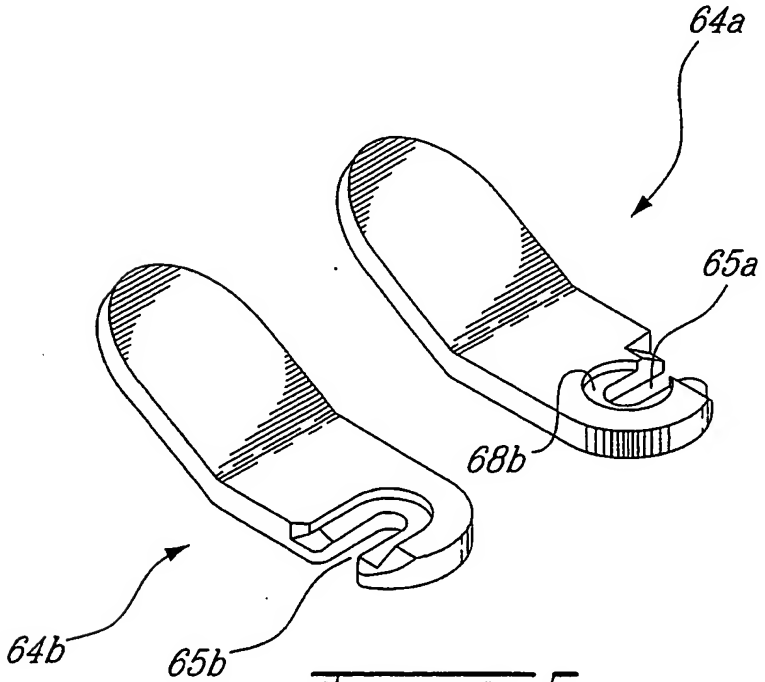

Fig. 5

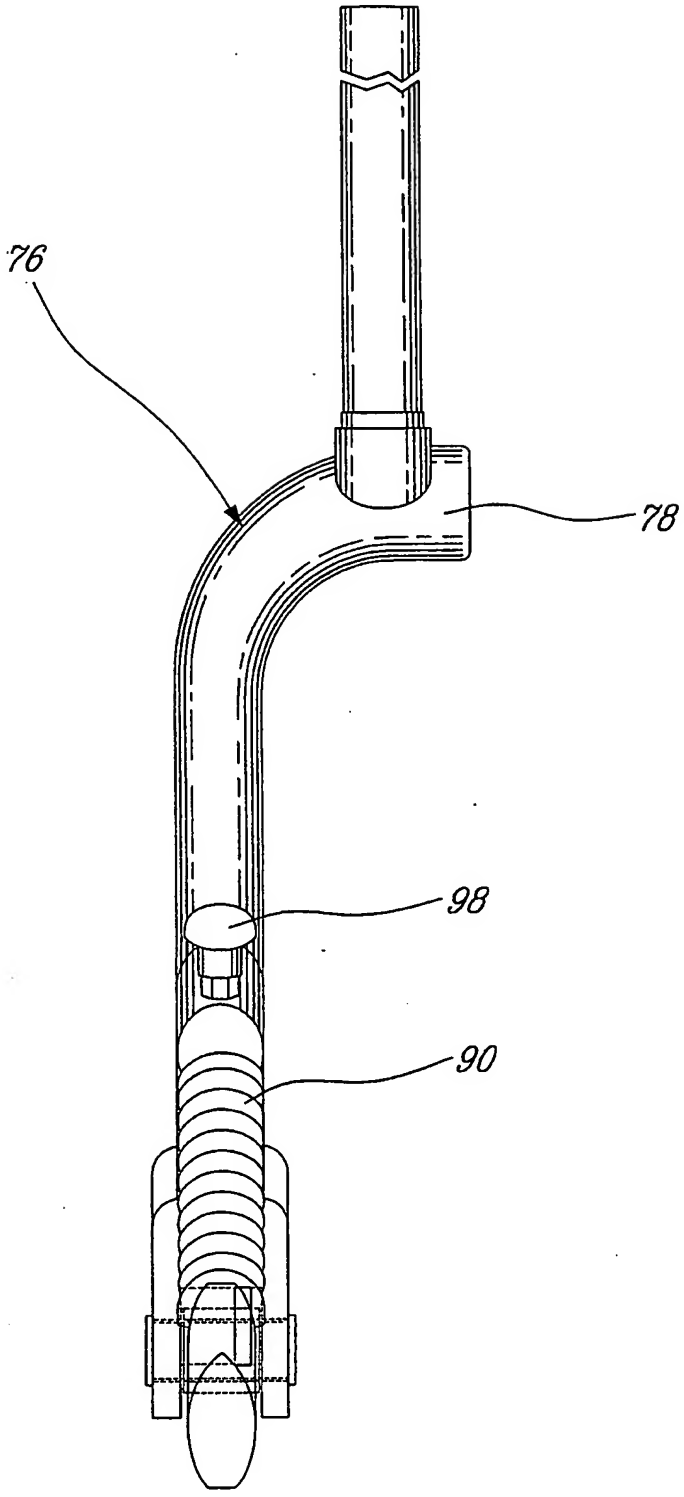

Fig. 6

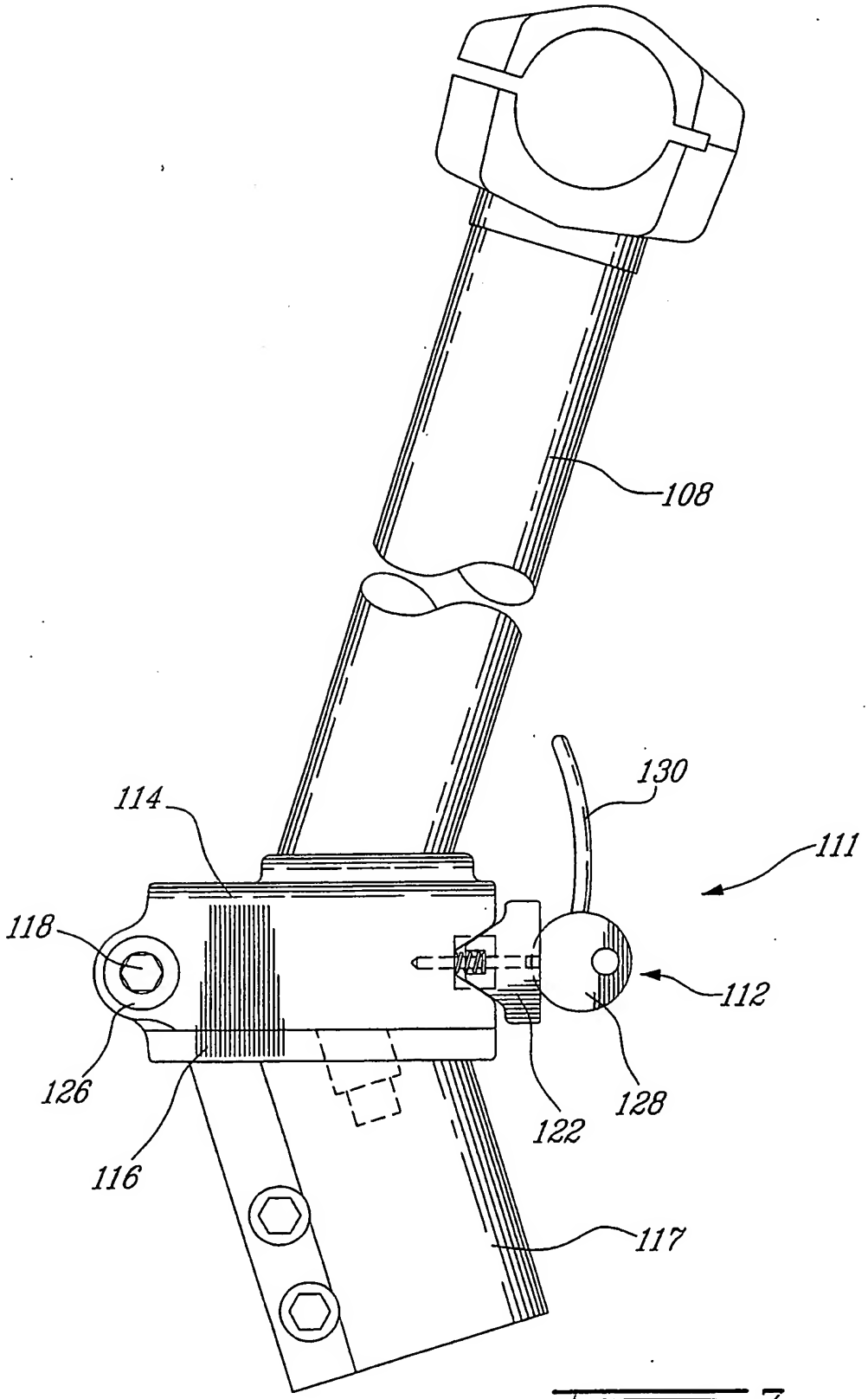

Fig. 7

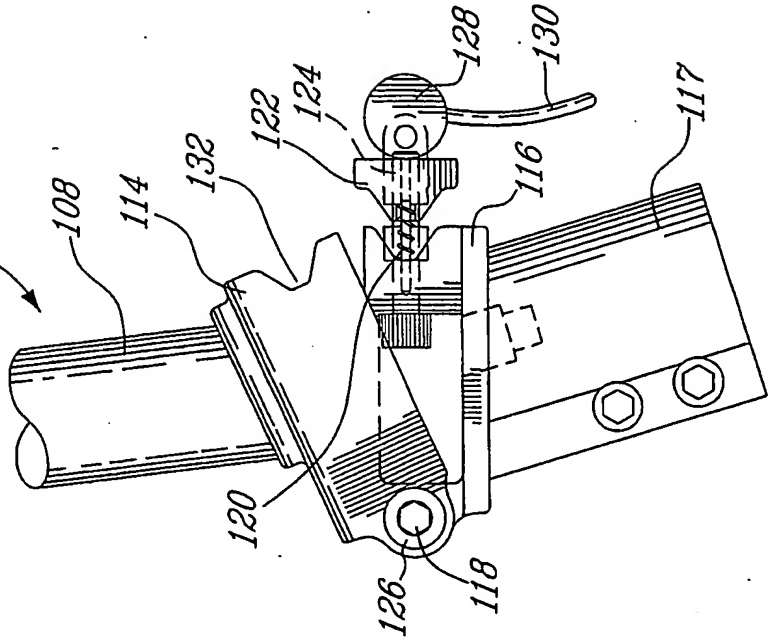
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Fig. 8

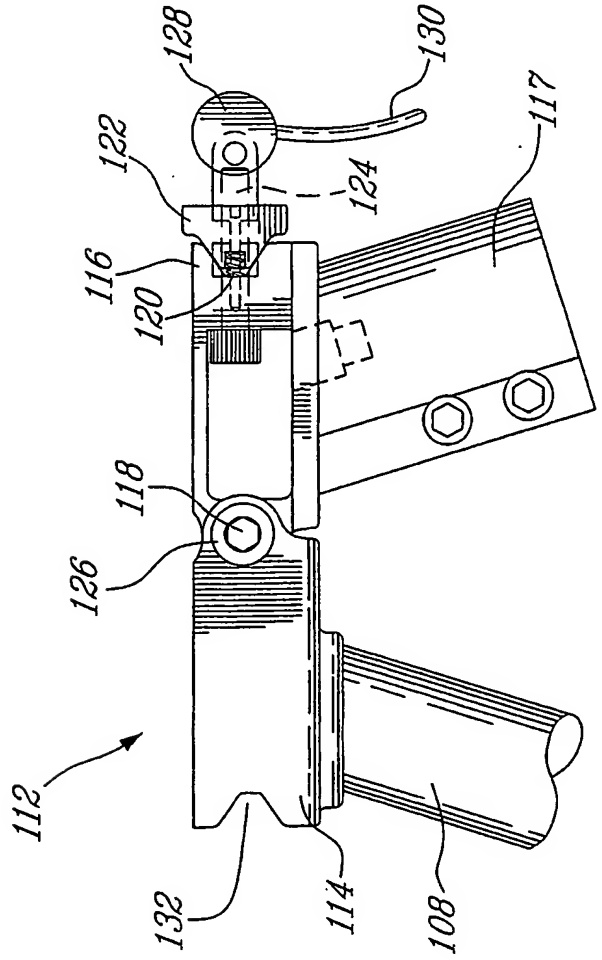
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Fig. 9

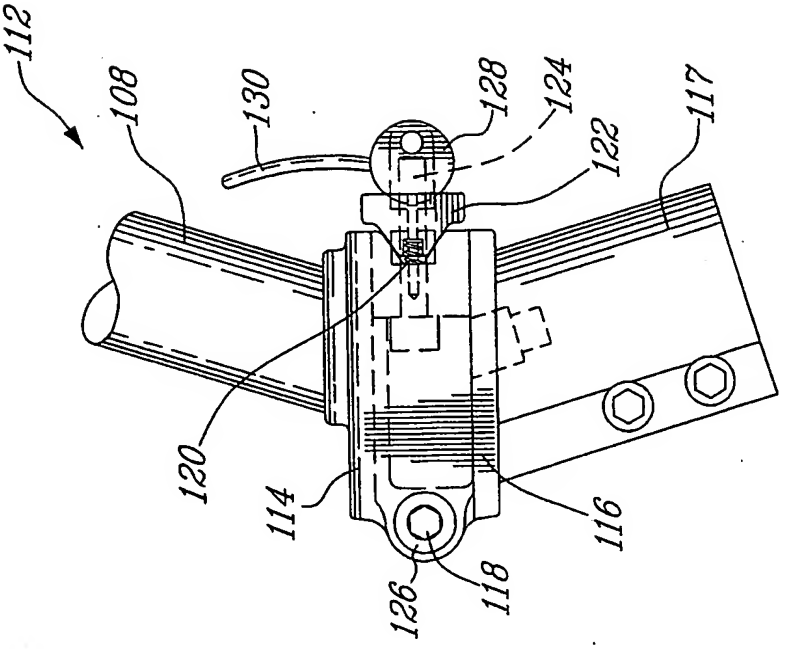
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Fig - 11

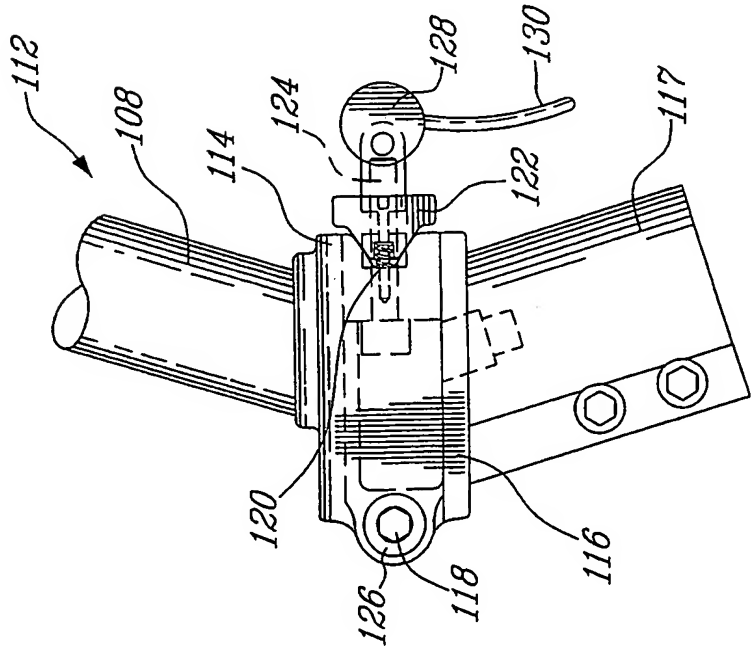
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Fig - 10

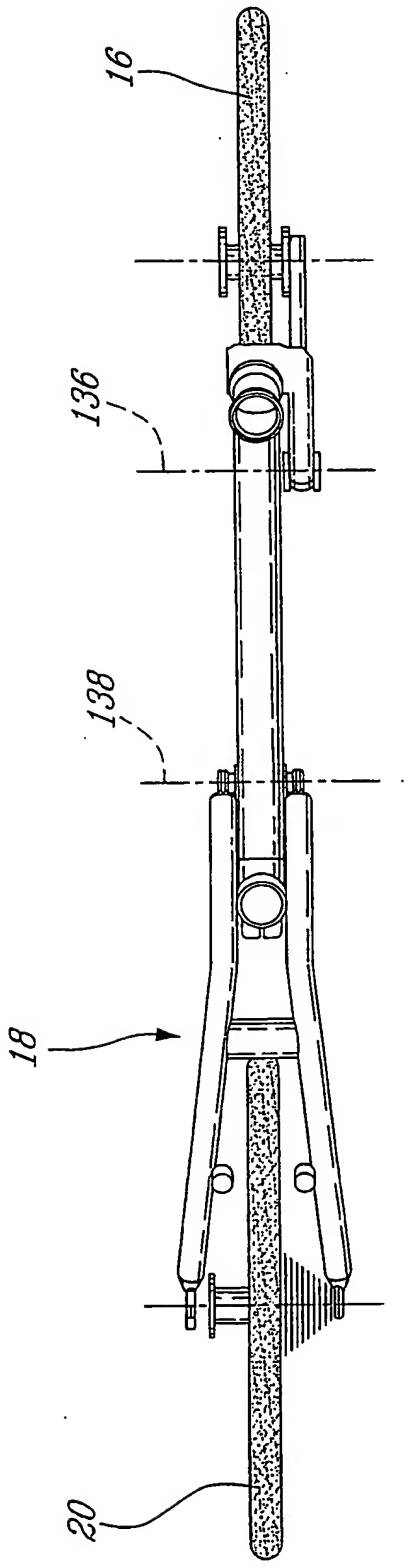

Fig - 12

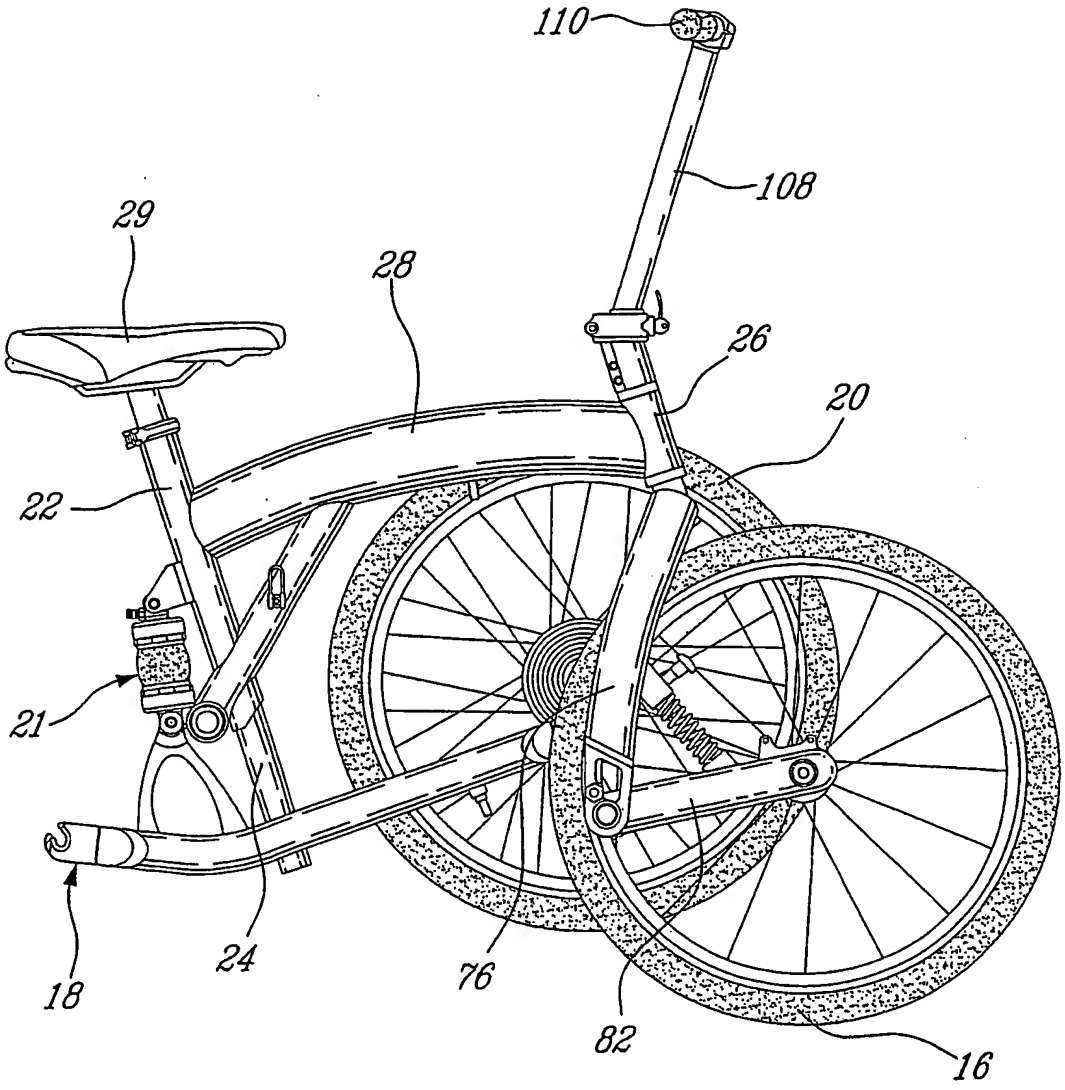

Fig. 13

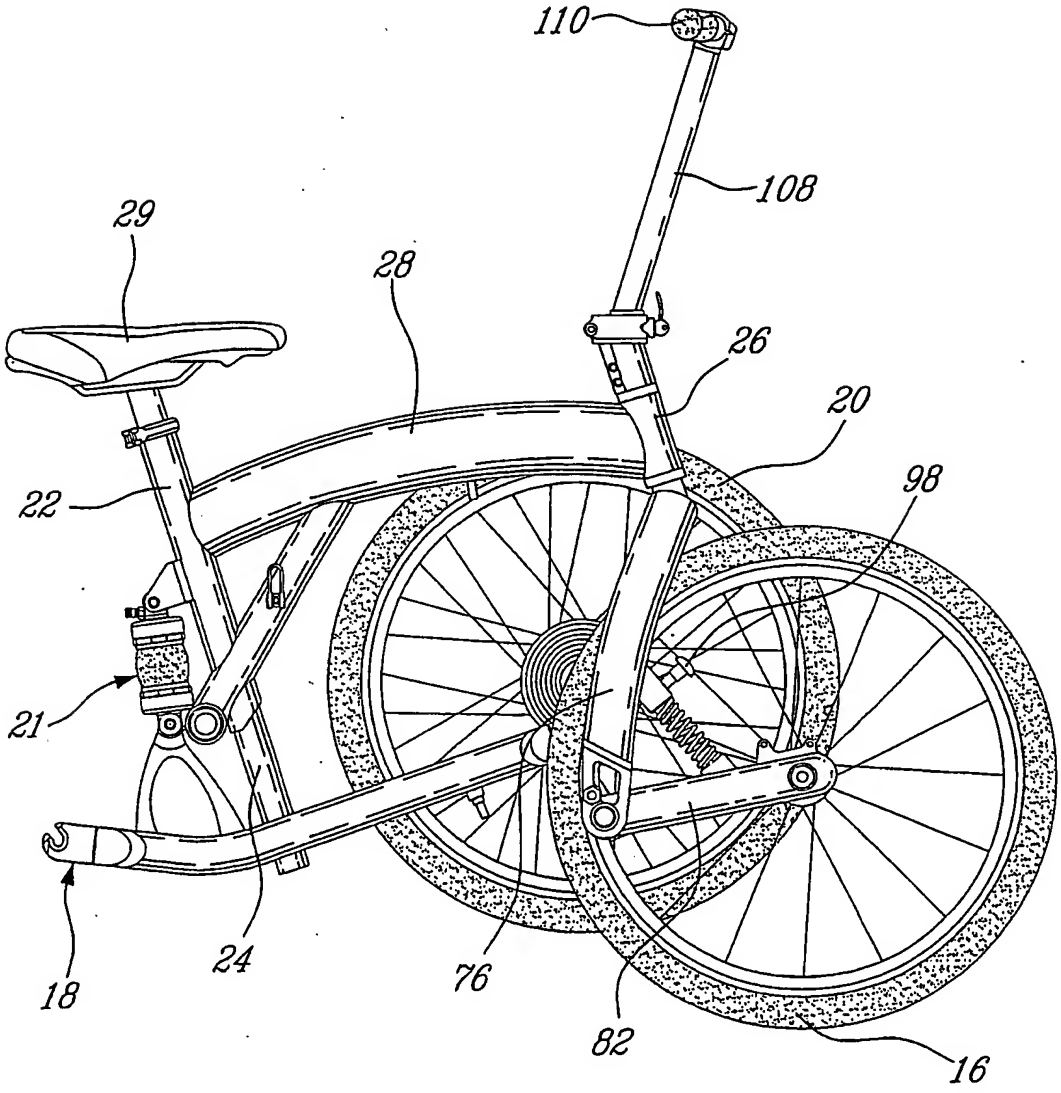

Fig. 14

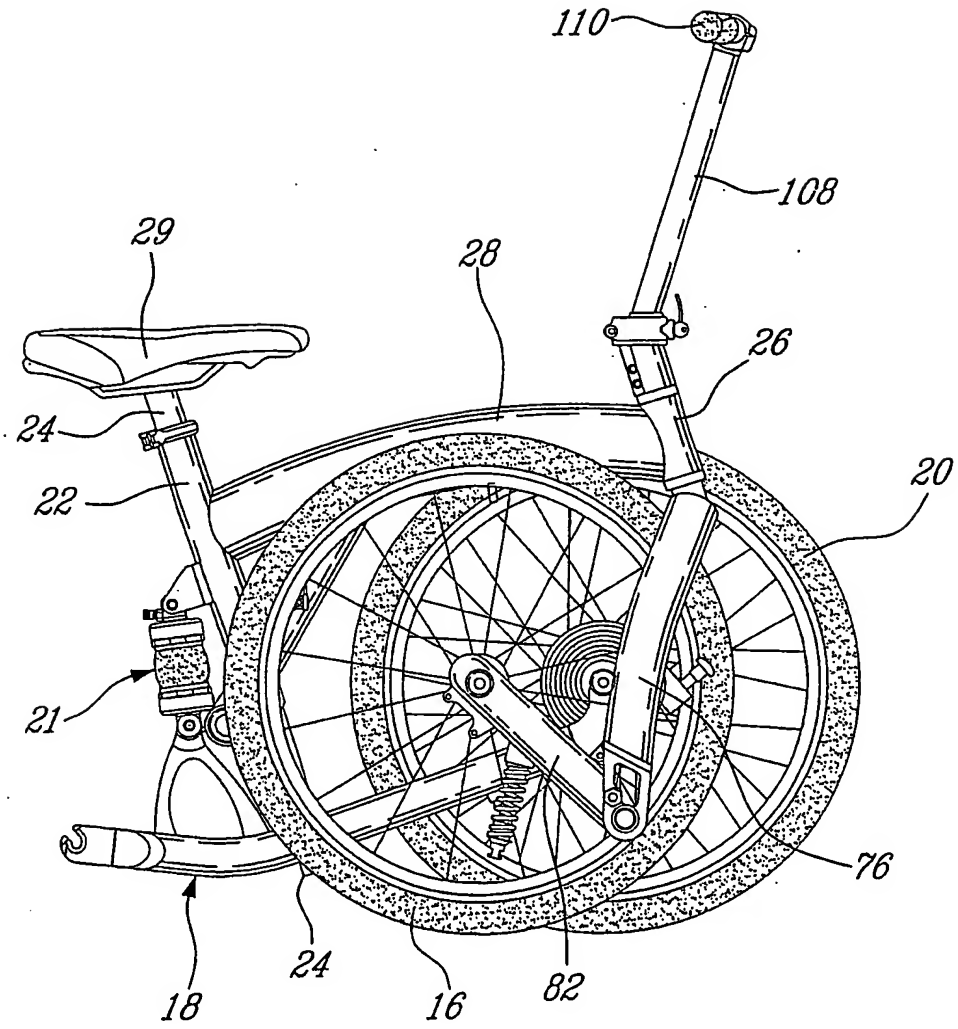

Fig. 15

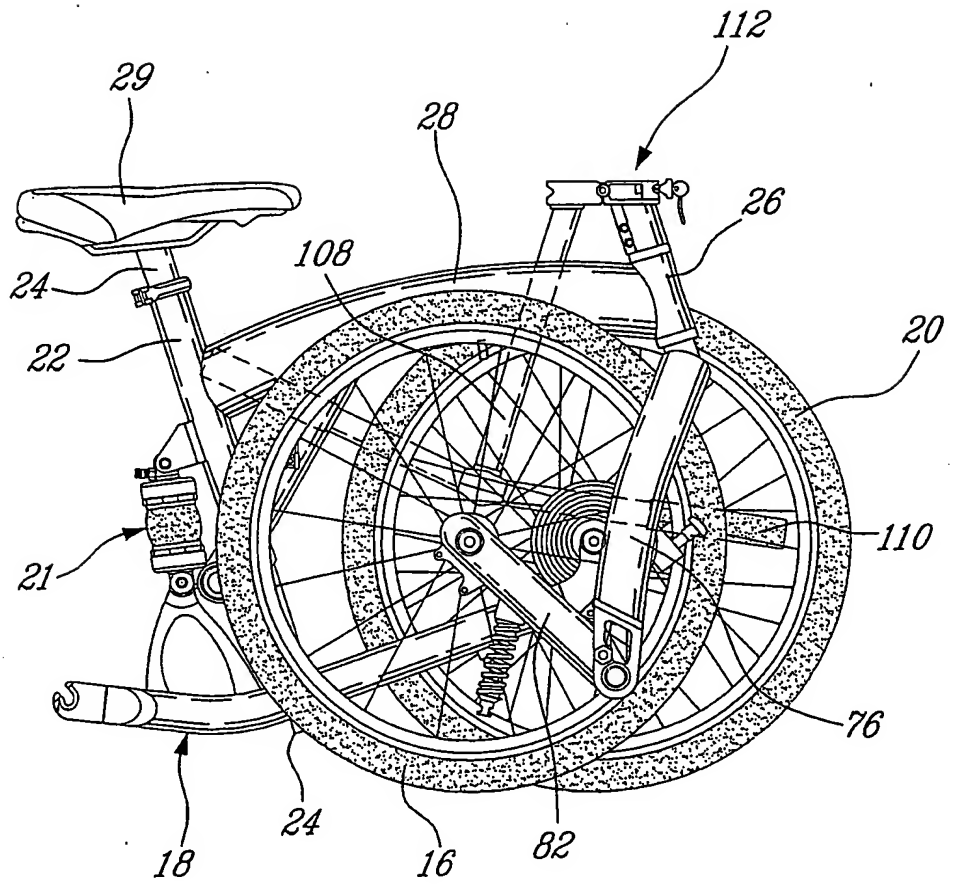

Fig. 16

INTERNATIONAL SEARCH REPORT

Inte[redacted] Application No
PCT/CA 03/01406

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B62K15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B62K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 142 780 A (SONY CORP) 10 October 2001 (2001-10-10)	22
Y	the whole document	23,24
A		1,26
Y	WO 00 05128 A (HARRINGTON DUNCAN MACKENZIE ;MCNEIL ALEXANDER MCKECHRAN HAR (AU);) 3 February 2000 (2000-02-03)	23,24
A	page 3 -page 6; figures 1-4,10-12,14,15	1,22,26
Y	DE 44 23 647 A (MUELLER THOMAS) 11 January 1996 (1996-01-11)	1,2,5,9, 10,26
A	the whole document	16,22
Y	DE 100 45 844 A (MANUFACTUM PRODUKT GMBH) 4 April 2002 (2002-04-04) paragraph '0015! - paragraph '0068!; figures 1-9	1,2,5,9, 10,26
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 January 2004	22/01/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Jung, W

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inte[redacted] Application No
PCT/CA 03/01406

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 12, 31 October 1998 (1998-10-31) & JP 10 194179 A (YAMAHA MOTOR CO LTD), 28 July 1998 (1998-07-28) abstract; figures 1-13	1,22,23, 26
A	US 6 267 401 B1 (DE JONG DIRK-KOEN) 31 July 2001 (2001-07-31) the whole document	1,22,26
A	EP 1 069 036 A (BAYERISCHE MOTOREN WERKE AG) 17 January 2001 (2001-01-17) the whole document	1,22,23, 26

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-21

A folding bicycle comprising a main frame, a front frame and a rear frame, wherein said front and rear frames are pivotable and laterally deflectable off a plane of said main frame and wherein said rear frame is set to pivot on a pivot axis perpendicular to said main frame

2. Claims: 22-25

A folding bicycle comprising a main frame, front and rear forks, said front and rear forks being mechanically releasable and wherein said rear fork has a folded pivot axis perpendicular to a plane of said main frame and is linked to said main frame so as to be laterally movable off the plane of said main frame

3. Claim : 26

A folding bicycle comprising a main frame, a front frame and a rear frame, wherein said front and rear frames are pivotable and laterally deflectable off a plane of said main frame and wherein said rear frame is set to pivot on a pivot axis perpendicular to said main frame, wherein a linkage being laterally movable relative to said main frame pivotally connects rear and main frame

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA 03/01406

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

[redacted]mation on patent family members

Int[redacted] Application No
PC[redacted]CA 03/01406

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